

# Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

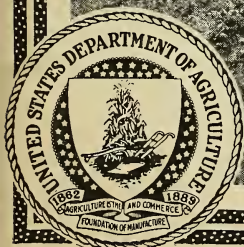


# U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1028

Rev. ed.  
follows

## STRAWBERRY CULTURE EASTERN UNITED STATES



**T**HE STRAWBERRY, the most popular small fruit, not only is produced on a large scale for market in many localities, but is found in almost every home garden.

The fundamental principles of strawberry growing are quite similar everywhere, but methods of culture vary somewhat in different parts of the country because of differences in soil and climate.

This bulletin discusses commercial methods in the eastern United States, the territory including approximately one tier of States west of the Mississippi—that part of the country where farm crops are usually grown without irrigation—but not including the South Atlantic and Gulf coast region.

The successful cultural methods followed in the different strawberry districts are described. These commercial methods are not all applicable to the growing of strawberries in the home garden, but as the underlying principles are the same, the practices may be modified without difficulty.

Not only are complete directions given for planting, fertilizing, cultivating, harvesting, and marketing, but methods of using the surplus in canning, preserving, and by means of cold storage for future use are presented.



# STRAWBERRY CULTURE: EASTERN UNITED STATES.

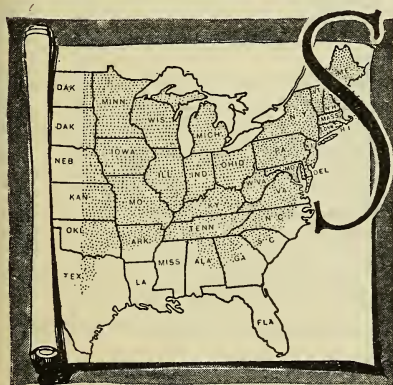
GEORGE M. DARROW,

*Pomologist, Office of Horticultural Investigations, Bureau of Plant Industry.*

## CONTENTS.

	Page.		Page.
Region to which this bulletin applies.....	3	Use of lime.....	33
Importance of the strawberry.....	3	Irrigation.....	33
Why cultural practices vary in different regions.....	5	Mulching.....	34
Extent of strawberry shipments.....	6	Picking.....	37
Raising strawberries as a truck crop.....	9	Keeping after picking.....	38
Where to grow strawberries.....	9	Duration of the plantation.....	39
Choosing the site for a plantation.....	10	Renewing the plantation.....	40
Preparation of the soil.....	12	Fall-set plants for fancy fruit.....	42
Establishing a strawberry plantation.....	14	Frost protection.....	43
Care during the first summer.....	26	Propagation.....	43
Companion crops with strawberries.....	29	Plants with perfect and imperfect flowers.....	45
The strawberry as an intercrop.....	31	Varieties.....	46
Fertilizers.....	31	Uses of the strawberry.....	47

## REGION TO WHICH THIS BULLETIN APPLIES.



STRAWBERRIES are widely grown in the eastern part of the United States. The area to which this bulletin applies is shown in the shaded part of the initial picture and includes in general the humid part of the eastern half of the United States, except a narrow strip along the South Atlantic and Gulf coasts where the elevation is below 500 feet. The southern boundary is for the most part the northern limit of the Coastal Plain region. This boundary extends

from the mouth of the Potomac River southwest through North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, and Texas. The western boundary is approximately the eastern edge of the Great Plains area.

## IMPORTANCE OF THE STRAWBERRY.

The strawberry is the most important small-fruit crop in the United States. Not only is it one of the most popular fruits, but it is

the most widely grown of any, being cultivated commercially from northern Maine to Florida, and in all the irrigated areas of the West where fruits can be grown. It is particularly adapted to the home garden, as it ripens earlier than any other of our cultivated fruits, and enough to supply an ordinary family can be grown on a very small area.

The map (fig. 1) shows how widely the strawberry acreage in the United States is distributed, while Table I shows the acreage in each State. The table is based on the status of the industry in 1919 as reported by the Fourteenth Census. The map shows the distribution of the industry on the basis of the Thirteenth Census. In general there have been no important regional changes in the distribution of the industry during the past 10 years.

TABLE I.—*Strawberry acreage in the United States in 1919 as reported by the Fourteenth Census, arranged by States and divisions.*

Divisions and States.	Acres.	Divisions and States.	Acres.
New England :		South Atlantic—Continued.	
Maine.....	555	North Carolina.....	2,186
New Hampshire.....	366	South Carolina.....	312
Vermont.....	275	Georgia.....	665
Massachusetts.....	1,431	Florida.....	834
Rhode Island.....	90	East South Central :	
Connecticut.....	636	Kentucky.....	3,112
Middle Atlantic :		Tennessee.....	10,876
New York.....	4,872	Alabama.....	1,359
New Jersey.....	5,029	Mississippi.....	691
Pennsylvania.....	4,008	West South Central :	
East North Central :		Arkansas.....	8,324
Ohio.....	4,172	Louisiana.....	4,007
Indiana.....	3,401	Oklahoma.....	302
Illinois.....	4,985	Texas.....	503
Michigan.....	8,048	Mountain :	
Wisconsin.....	3,652	Montana.....	155
West North Central :		Idaho.....	469
Minnesota.....	2,768	Wyoming.....	39
Iowa.....	4,472	Colorado.....	653
Missouri.....	8,645	New Mexico.....	28
North Dakota.....	93	Arizona.....	20
South Dakota.....	227	Utah.....	254
Nebraska.....	754	Nevada.....	5
Kansas.....	1,188	Pacific :	
South Atlantic :		Washington.....	3,087
Delaware.....	3,503	Oregon.....	2,812
Maryland.....	7,096	California.....	4,974
District of Columbia.....	10		
Virginia.....	2,446	Total, United States.....	119,395
West Virginia.....	1,006		

The total area devoted to strawberries in 1909, as reported by the Thirteenth Census, was 143,045 acres, or nearly 24,000 acres more than in 1919. The yield for 1909 was more than 255,000,000 quarts. In 1919 it was approximately 177,000,000 quarts. However, the yield from the same acreage may vary considerably from year to year, so that records for any particular year need to be considered with respect to crop conditions. The strawberry is a very intensive crop, and relatively large yields and large gross returns are necessary to make the industry profitable.

## WHY CULTURAL PRACTICES VARY IN DIFFERENT REGIONS.

In years past, the strawberry was grown only in the home garden and by gardeners located within a few miles of the market. The fruit was consumed during a very short season, the average length being about three weeks. Since about 1860 the period of its consumption has been greatly extended, and now in the large city markets strawberries can be obtained throughout the year. Relatively large quantities are consumed from early April until July, and smaller quantities of the everbearing varieties may be purchased from July until

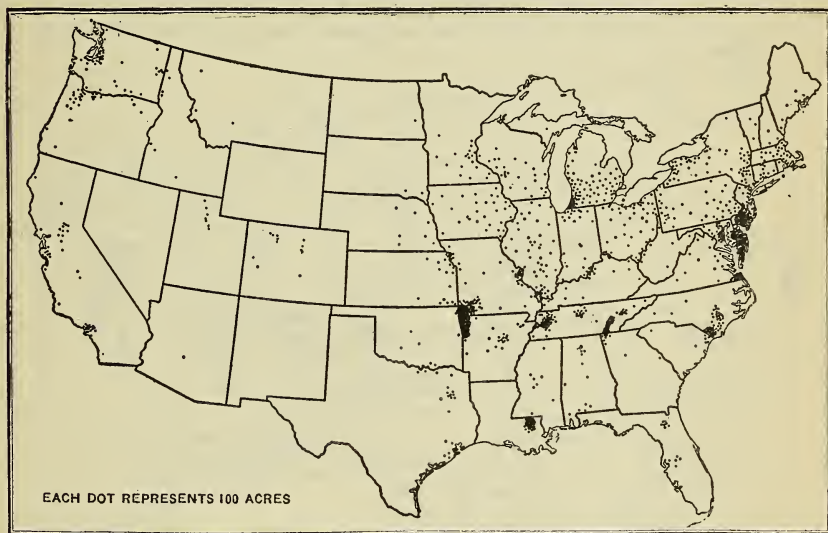


FIG. 1.—Outline map of the United States, showing the acreage of strawberries in 1909, according to the Thirteenth Census. (From *Geography of the World's Agriculture*, 1917.) This map visualizes the geographical distribution of the commercial strawberry industry at that time, since when there have been no important changes.

November, after which berries are shipped from Florida until April of the succeeding year.

With the growth of the strawberry industry in so many different regions and under such different conditions, cultural methods particularly adapted to the local requirements in each region have been developed. In arid regions strawberries must be irrigated and all cultural methods adapted to irrigated conditions. In Florida the climate makes it necessary to adopt special cultural practices not required elsewhere. There plants must be set in late summer and early autumn in order to secure fruit at the season of highest prices.

In nearly all regions varieties must be selected which will ripen at times when the market is in the best condition and when there is the least competition from other localities. Thus, in Florida, strawberries ripen and are shipped to northern markets from December 1 until the last of March or into April. As the season advances localities farther north and nearer the larger cities supply



the markets, until in June the territory immediately around Philadelphia, New York, and Boston supplies the same markets which were supplied in March largely by Florida; in April by Florida, North Carolina, and points farther west; in early May by North Carolina and Virginia; and in the latter part of May by Maryland and Delaware. When several points supply the same market, as in this instance, those farthest from the markets are at a disadvantage, as the freight and express rates are higher than for nearer points, and usually the berries can not arrive in as good condition. The more southern points, therefore, raise chiefly early sorts, for late varieties compete with berries grown near the large markets of the North.



FIG. 2.—Outline map of the United States, showing the average number of carload shipments of strawberries for 1914 and 1915, together with the approximate shipping season for each section. The dots represent 10 carloads each, except where they occur singly, when they may represent any number of carloads up to 10. (Adapted from data in Department of Agriculture Bulletins 237 and 477.)

### EXTENT OF STRAWBERRY SHIPMENTS

The map (fig. 2) shows the location of the principal strawberry shipping districts in the United States, and the approximate shipping season for each. Strawberries which supply the northern markets after the first part of June are largely raised in the immediate vicinity of the towns and cities and are not shipped any great distances. If this map (fig. 2) is compared with figure 1 it will be noted that while strawberries are grown extensively in the Northern States, the acreage is scattered rather than centralized in certain definite regions, as is the case in the States farther south.

Table II shows the number of cars of strawberries shipped from each State during the seasons of 1920, 1921, and 1922, and gives the carload shipments by weeks for the main shipping season, April to June, inclusive, for the same years.



TABLE II, SECTION 1.—*Monthly carload shipments of strawberries for 1920, 1921, and 1922, arranged by States.*

[These figures were furnished by the Bureau of Agricultural Economics. There were no carload shipments in December of those years; or in January, February, or November, 1920; or for August, September and November, 1922.]

States.	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Totals by years.							
	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1920	1921	1922					
Alabama.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	147	285	460					
Arkansas.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	896	1,094	2,165					
California.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	569	291	181					
Colorado.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2					
Connecticut.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12					
Delaware.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14					
Florida.....	10	17	40	105	44	53	155	109	5	45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	640	856	940					
Georgia.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	153					
Idaho.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....					
Illinois.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4					
Indiana.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	98	74	260					
Iowa.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	51					
Kansas.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	73					
Kentucky.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8					
Louisiana.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	772					
Maryland.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	858					
Massachusetts.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,576					
Michigan.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	787					
Mississippi.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,069					
Missouri.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	87					
Montana.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	439					
New Jersey.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	455					
New York.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	640					
North Carolina.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31					
Ohio.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50					
Oklahoma.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	89					
Oregon.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,963					
Pennsylvania.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4					
South Carolina.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	559					
Tennessee.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	425					
Texas.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	274					
Utah.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	362					
Virginia.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	244					
Washington.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	479					
Wisconsin.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,101					
Total.....	10	17	40	105	44	675	2,455	887	2,128	2,401	3,511	6,016	12,940	3,473	1,763	2,925	403	29	79	112	11	58	13	2	9	4	1	8,490	10,695	18,716

TABLE II, SECTION 2.—Weekly carload shipments of strawberries in April, May, and June, 1920, 1921, and 1922.

States.	April.						May.						June.					
	1st week.			2d week.			3d week.			4th week.			5th week.			6th week.		
	1920.	1921.	1922.	1920.	1921.	1922.	1920.	1921.	1922.	1920.	1921.	1922.	1920.	1921.	1922.	1920.	1921.	1922.
Alabama.....	72	41	15	49	103	32	29	80	23	31	61	23	14	55	11	12	21	4
Arkansas.....	5	5	20	1	86	10	1	86	10	8	253	69	121	246	406	311	131	304
California.....			3	1	6					2	10	24	18	43	14	45	43	44
Colorado.....																		
Connecticut.....																		
Delaware.....																		
Florida.....	19	3	26	22	1	11	56	2	11							41	381	225
Georgia.....																		
Idaho.....																		
Illinois.....																		
Indiana.....																		
Iowa.....																		
Kansas.....																		
Kentucky.....																		
Louisiana.....	85	178	210	200	137	411	223	216	374	172	180	275	146	82	181	32	52	95
Maryland.....																		
Massachusetts.....																		
Michigan.....																		
Mississippi.....	14			10	8	9	3	14	7	28	13	4	25	2	6	8	2	3
Missouri.....																		
New Jersey.....																		
New York.....																		
North Carolina.....	35	1		118	55	178	196	51	106	267	146	22	357	159	3	166	69	2
Ohio.....																		
Oklahoma.....																		
Oregon.....																		
Pennsylvania.....																		
South Carolina.....																		
Tennessee.....																		
Texas.....																		
Utah.....																		
Virginia.....																		
Washington.....																		
Wisconsin.....																		
Total.....	104	307	278	237	338	588	322	629	679	280	800	806	490	911	1,990	811	1,271	3,404

## RAISING STRAWBERRIES AS A TRUCK CROP.

In the United States the strawberry is grown in the home garden, by market gardeners, by truck growers, and also as a farm enterprise. Occasionally the fruit is grown in a greenhouse as a forced crop for a very special and high-priced market.

**Home garden varieties.**—When raised in the home garden, varieties which have the best dessert quality and ripen through a long season or in succession, without reference to their ability to stand long shipments, are desired. Such berries are given intensive cultivation and may be treated somewhat differently from those grown for market.

**Strawberries for market gardens.**—Market gardeners also raise strawberries under intensive methods of culture; and since they are located near the markets in which their crops are sold, they have not been interested primarily in the shipping quality of varieties. However, at times such markets may be oversupplied with fruit, so that a part of the crop must be shipped to another market or held for a few days in storage. The market gardener, therefore, should pay more attention to the shipping quality of the varieties planted and should adopt more of the practices of truck growers.

**Strawberries for truck growers.**—Truck growers raise the fruit for the general market as one of their truck crops. Under such conditions the strawberry is given intensive culture, and the varieties raised must have good shipping qualities. Varieties have been introduced which combine good shipping and high dessert qualities, and it is becoming essential that truck growers as well as others raise these sorts.

**Strawberries as a farm crop.**—When grown as a farm enterprise the methods used are not generally intensive. In some localities, however, intensive methods have been adopted by farmers, and these growers usually have been especially successful. They have found the thorough culture of a few acres more profitable than less intensive methods on a larger area.

In the discussion of cultural methods which follows, directions for growing the strawberry as a truck crop will be given, and where such methods differ from those used in home gardens that fact will be indicated.

## WHERE TO GROW STRAWBERRIES.

The points which should be considered in locating a commercial strawberry plantation are (1) the accessibility of markets, (2) transportation facilities, (3) labor supply, and (4) community interests and climate.

The strawberry may be grown in any part of the United States except in the arid and semiarid regions of the West where water for



irrigation is not available. Within the northern part of the United States, however, are certain areas where only a few varieties have proved hardy enough to be grown successfully. In northern Illinois, in northern Missouri, and in Wisconsin, Minnesota, Iowa, Nebraska, South Dakota, and North Dakota most varieties are somewhat tender, and none should be planted widely until careful trial has proved it to be hardy. Certain sorts, however, especially the Dunlap, Warfield, and Progressive, are exceptionally hardy and may be grown throughout this area, except perhaps in the most exposed places. If given winter protection, they may be grown even in the colder parts of Iowa and Minnesota.

In deciding upon a location for raising strawberries, the possibility of securing labor to harvest the fruit should be carefully considered, as the commercial success or failure of the crop will often depend upon this factor alone.

When strawberries are to be grown for the general markets it is usually better to select a locality where others are raising them. Pickers can usually be secured in such places more easily, and because of the possibility of cooperative handling, baskets, crates, and other supplies can be obtained to better advantage. Furthermore, consignments from several growers can be combined, thus often making car-load shipments possible when, without this combination, small shipments by express would have to be made.

### CHOOSING THE SITE FOR A PLANTATION.

The factors which should be considered in selecting a site for a strawberry plantation are air and water drainage, slope, the exposure of the land, and soil.

#### AIR DRAINAGE.

In localities subject to late spring frosts, a site somewhat elevated above the surrounding country should be selected. Cold air settles into low places, and frosts occur there more frequently than on the more elevated sites. As the strawberry plant is close to the ground, the blossoms are often caught by unseasonable frosts when the blossoms of fruit trees occupying the same ground would escape. A site with even a slight elevation above the surrounding country will often escape injury from frosts because of the air drainage thus provided.

#### WATER DRAINAGE.

Strawberries thrive best on soil which is naturally moist but not wet. Plants which are on wet soil usually make very little growth in the summer and are likely to be killed when the ground freezes in the winter. Therefore, the site chosen for a strawberry field should be well drained.

## SLOPE AND EXPOSURE.

Ordinarily a site having a gradual rather than a steep slope should be selected for the strawberry. Heavy precipitation, together with a deficient supply of humus, causes soils to wash badly on steep slopes, and cultivation will be expensive. Where strawberries are grown on hillsides, the rows should follow the contour of the hill, as shown in figure 3.

By choosing different slopes, it is possible to vary the period of ripening several days. Where it is important that the berries ripen as early as possible, a site having a southern exposure should be se-



FIG. 3.—A field of Gandy strawberries at Parkersburg, W. Va., trained to wide matted rows and well mulched. The rows follow the contours of the field.

lected, if available. A plantation with such an exposure absorbs more of the heat of the sun and the ground is warmer than on a northern slope. Berries may be secured from such plantations several days in advance of those on northern slopes. Where it is desirable that the crop ripen as late as possible, a northern exposure should be selected. Fields having such an exposure are cooler and the moisture conditions are usually better than in fields having a southern exposure.

## SOIL.

The strawberry not only has a wide climatic adaptation, but may be grown successfully upon almost any type of soil, from coarse sand to heavy clay, provided it is well supplied with moisture and



at the same time well drained. In certain regions strawberries are usually grown on sandy soils, while in others clay soils are preferred; a heavy yield may be secured in both cases. Although strawberries will grow in practically any kind of soil, particular soils are preferred for certain purposes. Thus, when early fruit is desired a sandy soil is often chosen, since the berries ripen somewhat earlier than on clay soils, other conditions being the same.

The various varieties of strawberries show decided differences in their behavior on different soils. Some are much better suited to clay or heavy soils, while others are adapted to sandy or light soils. All varieties, however, show less differences in their adaptation when there is a good supply of humus in the soil than when the humus is deficient. Therefore, in determining the suitability of a soil for growing strawberries the humus content with its effect on soil moisture and fertility is more important than the type of soil.

It is essential to the best success that the strawberry receive a plentiful supply of moisture throughout its growing period. When the moisture supply is deficient in early spring, the plants set little fruit. If the supply is deficient during the period when the fruit is growing and ripening, but few berries mature, and those are small. If later there is insufficient moisture few new plants are formed, and those that do form lack vigor. In some regions clay soils should be selected as affording the best moisture conditions throughout the year; in others, sandy soils should be chosen. In any soil the available moisture will be increased by an adequate supply of humus.

### PREPARATION OF THE SOIL.

The preparation of the soil for planting strawberries should begin usually at least two years before the plants are to be set, or the plants should be set in soil which has received adequate preparation in growing other crops. Newly plowed sod land should not be used, because the grass roots might prove objectionable, and because of the danger of injury to the plants from white grubs. The land must also be freed of quack-grass or any other seriously persistent weeds, and a suitable supply of humus must be furnished if it is not already present.

### CLEANING THE SOIL.

**Destroying white grubs.**—The larvæ of May beetles, or June bugs, called white grubs, occur throughout the strawberry regions of the eastern part of the United States. They are commonly found in sod land, and are very destructive to strawberries planted on infested soil. The beetles lay their eggs in grass lands, and the larvæ stay in the soil for two years before becoming mature. It is, therefore, essen-



tial, where white grubs cause serious damage, that the ground be freed from them by being planted to cultivated crops for at least two seasons before strawberries are set.

Where the white grub is less serious, the soil should be plowed in the autumn. The resulting exposure during the winter will kill many of the grubs. The following season some cultivated crop should be raised, the soil plowed again in the autumn, and the following spring the strawberries planted. As the grubs may travel for some distance in the soil, it is often necessary to have a plowed area around the strawberry field; otherwise, plants may be killed for some distance from the border by the grubs which come from the neighboring grass land.<sup>1</sup>

**Exterminating quack-grass and weeds.**—It is not usually advisable to raise strawberries in a field where quack-grass is abundant, as it is almost impossible to kill out the grass after the plants are set, and if allowed to grow it will make the strawberry field unproductive. For a season or two previous to setting strawberries, land infested with quack-grass or other weeds which are difficult to eradicate, such as purslane, chickweed, and the like, should be freed by growing crops which require clean cultivation.

#### ADDING HUMUS AND FERTILITY.

**Green-manure crops.**—Soils lacking in humus should be planted first to some green-manure crop, or receive an application of stable manure. Soils which are very deficient in humus may need at least two green-manure crops turned under before strawberries are planted. Ordinarily, however, one crop of crimson clover or rye and vetch will be sufficient. Where these can not be grown successfully, cowpeas, Canada peas, buckwheat, or some other crop commonly used for green-manure purposes can be substituted therefor. The kind of green-manure crop to be used will differ in various parts of the country; the one found to be best suited to any particular region should be used.

**Using stable manure.**—The extent to which the land to be set to strawberries should be enriched will depend somewhat upon the length of time the berries are to be grown on it. In most localities, the strawberry plantation is continued for several years on the same soil, and such soil should be put in the best possible condition before the plants are set. In other localities, strawberries are grown for a single crop, and less extensive preparations need be made.

Some growers have found that sufficient humus can be supplied by using a large quantity of stable manure on a hoed crop planted the

<sup>1</sup> For further information on white grubs, readers are referred to *Farmers' Bulletin* 543, entitled "Common White Grubs," which may be obtained free by applying to the Secretary of Agriculture.

year previous to setting strawberries, and then following the hoed crop with a green-manure crop. When practices such as are outlined here are used, little stable manure will be needed before the strawberry plants are set. It will seldom be convenient to use green-manure crops as a source of humus in the home garden; therefore, stable manure will generally be preferred.

**Rotation of crops.**—Since it is necessary where white grubs are troublesome that a hoed crop be raised during at least one season before the strawberry plants are set, and since it is also essential that the sod be broken up where such land is to be fitted for strawberries in order to put it in good physical condition, growers should use some well-planned rotation as a means to this end. Rotations which are desirable are those which include the clovers or other leguminous plants and truck or other hoed crops.

In some localities the land on which strawberries are to be grown is kept in clover for one or two years, then plowed in the autumn and sowed to crimson clover or rye and vetch. Early the following spring the green-manure crop is plowed under and some vegetable crop raised, such as potatoes, beans, peas, or tomatoes. In the autumn, after the vegetable crop has been harvested, the land is plowed, or perhaps left without further attention until the following spring, when it is fitted for planting and strawberries are set. After one or more crops of berries have been obtained, the field is plowed and again seeded to clover. This rotation is suggestive only, as the best crops to raise depend on local conditions.

**Final preparation of the soil.**—Whatever the previous crop may have been, the land should be thoroughly pulverized immediately prior to setting the plants. If the soil has been plowed in the autumn, in many cases it will not need to be plowed again in the spring, thorough harrowing being sufficient.

Under most conditions, level culture should be used. Occasionally where the surface drainage is poor, a ridge on which to plant the strawberries may be made by throwing two or more furrows together and leveling with a plank drag. The height and width of the ridge should be determined by the character of the soil. Unless the drainage is very poor, the ridge should be relatively wide and only 2 or 3 inches high.

## ESTABLISHING A STRAWBERRY PLANTATION.

### SEASON OF PLANTING.

The factors which determine the season of planting are temperature, moisture, and type of soil.

Where there is a continuous covering of snow in the winter the planting can be done in the autumn, but where this is lacking, and

alternate freezing and thawing occur, the planting should be done in the spring unless some protection is given the plants. In the Middle West, growers occasionally set plants in the autumn, but they must protect them during the winter with several inches of straw or with a heavy coating of stable manure containing considerable straw. In most of the Northeastern States the snow covering is heavy, and plants may be set in the autumn. However, if the season has been dry and the soil does not contain an abundant supply of moisture, strawberries can not be planted safely in the autumn even in those States. Neither should the plants be set in the autumn in seasons when there is a surplus of moisture. Under either extreme, winter injury is likely to occur.

**Moisture important.**—Plants may be set at any time in the spring or summer if moisture conditions are favorable; these are usually best in early spring, and most of the planting is done then. Where it is possible to irrigate, planting may be done at almost any time. Often near large cities where the land must be utilized to the fullest extent and where abundant rainfall can be depended on, plants of certain varieties are set in August or early in September and a crop secured the following year. When set at this season a large quantity of stable manure is used, so that the plants may be protected as fully as possible during the winter and so that the roots can grow until very late in the autumn and start to grow early in the spring.

**Kind of soil to be considered.**—Plants may be set on sandy soils in autumn when it would not be safe to plant them on clay soils. When clay soils freeze and thaw, they are likely to heave the plants out of the ground and destroy them. As there is only a short time in the spring when conditions are just right for setting plants on clay soils, early autumn will often be found a more desirable planting season even on them. It is essential that plants on such soils be protected by a mulch in winter.

**Spring planting preferred.**—Where planting is practicable in the autumn, that season is most desirable, as the plants can get well established in the ground and begin growth very early in the spring. Also, it is sometimes possible to obtain labor in the autumn when it can not be had in the spring. In general, however, early-spring planting is preferred by most growers, as the moisture supply is most favorable at that time. Then, too, it is much easier to secure nursery-grown plants in the spring, as nurserymen do not usually care to supply them during the period when planting conditions are best in the autumn, as they want to take advantage of those same conditions for largely increasing their own stock.

In southern New Jersey and the southern parts of Ohio, Indiana, and Illinois the usual planting season is late March and early April.



Farther north the plants should be set in April or as early in May as it is possible to prepare the soil.

#### CARE OF PLANTS.

When the plants are received from the nursery, the outer and older leaves usually have been removed, and only one to three young leaves in the center left on. Such plants are easier to handle and will grow better than if the older leaves had been allowed to remain.



FIG. 4.—A, Strawberry plants in bundles as received from the nursery. To the left is shown a single plant and a bundle of 27 plants of the Dunlap, to the right a single plant and a bundle of 27 plants of the Pearl. These are good plants of each variety for setting, even though they have very different root systems. Other varieties show even greater differences in the habit and vigor of their root systems than these do. B, C, Caring for strawberry plants received from the nursery. The bundles are opened and each plant placed in a trench separately. They should then be covered with soil to their crowns. (Photographed at Salisbury, Md., March 31, 1916.)

If the plants are in poor condition, however, all except one small leaf should be removed. The roots should look fresh and bright and usually white or slightly yellowish in color, though if grown on muck soil the roots will be dark. Old plants can usually be distinguished from young plants because some of their roots are black and dead. Plants in good shape for setting are shown in figure 4, A. The roots of these plants have not been pruned, and at present there

is no evidence to show that pruning the roots of strawberry plants preparatory to setting them is advantageous.

If the conditions are such that the plants can not be set for several days after their arrival, the bundles should be opened and the plants separated and heeled in, as shown in figure 4, *B* and *C*. The crowns of the plants should be placed even with the surface of the ground; then the trench filled with soil, which is packed around the roots firmly, so that it is in close contact with all of them.

If the roots are very dry upon arrival, they should be dipped in water and the plants then placed in a cool cellar for several hours before being heeled in. When they are heeled in later, the soil which is drawn about the roots of the plants should be moistened thoroughly. In case the plants are extremely dry, it may be necessary to allow them to start a new root system while they are heeled in and before they are set in the field.

#### SYSTEMS OF TRAINING STRAWBERRIES.

Two main systems of training strawberries are in general use—the hill system and the matted-row system.

**Hill system.**—The term “hill system” is used to designate the method of training where all runners are removed from the plants as they appear, so that at the fruiting season there are no more plants than were originally set. Such plants become much larger than those under the matted-row system, and bear more than the individual plants in matted rows where the runners are allowed to remain and take root. Under the hill system, the plants are set 6 to 24 inches (commonly 12 to 18 inches) apart in rows which are 3 to 3½ feet distant. When such a planting distance is adopted, a horse cultivator can be used, which greatly reduces the expense of tillage. In a home garden where horse cultivation can not be given, the distance between the rows need not be more than 18 inches. Sometimes two rows of plants are set from 6 to 24 inches apart; then a wider space is left and two other rows are set. These are called double or twin rows. Sometimes triple rows are set. These are, however, simply modifications of the hill system and the plants are set the same distance apart in the row. Figure 5, *A*, *B*, and *C*, shows strawberries in accordance with the hill system, in single, double, and triple rows, respectively.

**Matted-row system.**—Under the matted-row system the plants are set in rows and all or part of the runners which form during the summer are allowed to take root in the spaces between the original plants. By the end of the season, a mat of plants will have formed. The width of this mat may vary from a few inches to 2½ or 3 feet, and in a few localities may be even 4 or 5 feet.



It is easier to harvest the berries from plantations where the rows are narrow, and some varieties produce better under such conditions. When the width is greater than 2 feet, some ripe berries along the center are likely to be overlooked by pickers, and unless the plants are well spaced, many berries are likely to be small. In general, therefore, the width of the matted row of plants should not be more than 24 inches, and many growers find that rows about 12



FIG. 5.—A, Chesapeake strawberries grown in hills under irrigation. The third crop is being harvested from this plantation. (Photographed at Bridgeton, N. J., June 10, 1916.) B, Chesapeake strawberries grown in hills in double rows. The rows in each pair are 8 inches apart and the plants 6 inches apart in the rows. From center to center of each pair of rows the distance is 3 feet 8 inches. (Photographed at Vineland, N. J., June 12, 1916.) C, Strawberries set in hills in triple rows. The plants are 12 inches apart each way. The alley between the sets of triple rows is 18 inches wide. (Photographed at Three Rivers, Mich., June 29, 1916.)

inches wide are most desirable. Matted rows may be grown on the same plan as double or twin rows under the hill system; that is, two rather narrow matted rows from 6 to 24 inches apart may be allowed to form, then a wide alley be left and two other rows 6 to 24 inches apart formed.

Under the matted-row system, the plants should be set 18 inches to 42 inches apart in rows which are 3 to  $4\frac{1}{2}$  feet apart. Varieties which do not make runners readily, such as the Chesapeake, Superb,



and Columbia, should be set no farther apart than 18 inches, while the Dunlap, Warfield, and others may be set at a greater distance apart.

If there is much danger of loss of plants from white grubs or severe droughts, the planting distance in the rows for all varieties should not exceed 18 inches; then if a plant is lost from either of these causes, the adjoining plants will make sufficient runners to form a continuous mat.



FIG. 6.—A, Strawberries grown in accordance with the wide matted-row system in a peach orchard. (Photographed at Bridgeville, Del., June 2, 1916.) B, Marshall strawberries grown in spaced matted rows. The rows are  $4\frac{1}{2}$  feet from center to center. (Photographed at Marshfield Hills, Mass., June 20, 1916.) C, Strawberry plants set 30 by 36 inches apart under overhead irrigation. (Photographed at Rancocas, N. J., June 16, 1915, about two months after the plants were set.)

On steep slopes, the rows should be somewhat farther apart than on level or nearly level land. The rows ordinarily should be at least 4 feet apart on such sites. Certain varieties which make few runner plants on poor land may make a large number when on very fertile land. The plants of the Chesapeake, for example, should be set no farther apart than 18 inches on land of moderate fertility, but on very fertile land they will make a large number of runners and may be set much farther apart.

**Spaced matted rows.**—In matted rows the running plants may be allowed to root almost at will or may be placed by hand. When the

runners are set by hand, the row is called a spaced row. Sometimes only one runner is set on each side of the mother plant, and sometimes many runners are set, all at a distance of 6 to 10 inches apart. The system in which runner plants are spaced at equal distances on each side of the parent plant and in rows parallel to them is sometimes called the hedge-row system and each row a hedge row. In the spaced-row system the plants are simply spaced approximately equidistant from each other.

In practice, the hedge-row and spaced-row systems are used very little except on the Pacific coast. Only the matted-row system, in which the runners are allowed to form and root at will, is used extensively. Figure 6, *A* and *B*, illustrates the matted-row and the spaced matted-row systems, respectively.

In these various modifications of the matted-row systems, where only a limited number of runner plants are desired, all plants which form after the desired number has developed are removed, as in the hill system.

**Advantages and disadvantages of each system.**—The system of training to be used is determined chiefly by the climate, the variety, the soil, and the preferences of the grower. Commonly where the land is irrigated and tillage is intensive, growers find the hill and spaced matted-row systems better adapted to their purpose than the ordinary matted row.

Where there is considerable danger of injury from white grubs, from drought, or from severe winters, the hill system is not satisfactory, and, if used, there is frequently so great a loss that the remaining plants will not produce a profitable crop on the basis of the acreage concerned. In such localities, the matted-row system should be used, and, although some plants may be killed, enough will ordinarily survive to produce a good yield.

In rainy seasons the berries are somewhat more likely to rot in matted rows than if grown in hills, which give a better circulation of air around each plant. In seasons of less abundant rainfall, the larger yield of fields set in matted rows will in most cases more than make up for any loss in wet years.

**Different varieties for different systems.**—Certain varieties are much better adapted to the hill than to the matted-row system, while others give their best results in matted rows. Thus, the Chesapeake, Clark, and Marshall are frequently grown in hills, while the Dunlap, Gandy, and Aroma are rarely grown in any but matted rows. The last-named varieties make a large number of runners, and the expense of removing them would be comparatively heavy.

Certain varieties make very few plants on light soils, while on heavy soils a large number of runners are made. Such varieties are



more suited to the hill system of culture on sandy soils and to the matted-row system on heavier soils.

In the northern United States the hill system may be used by those growing strawberries in their gardens, by market gardeners who wish to grow the largest possible quantity of the highest grade of fruit on a small area, by those who use irrigation, and by those growing certain varieties that do not make many runners, such as the Chesapeake, Superb, Bubach, and Columbia. Under ordinary conditions, however, matted rows should be used in the whole of this area, while in the northern part of the Middle West, where there is danger of winter injury, matted rows should be used invariably.

Whether or not spacing the plants by hand under systems sometimes known as the hedge row or the spaced row will pay, can be determined only by trial. Such systems require much hand labor, both in placing the runners that are to form plants, and in removing all others that appear. In prac-

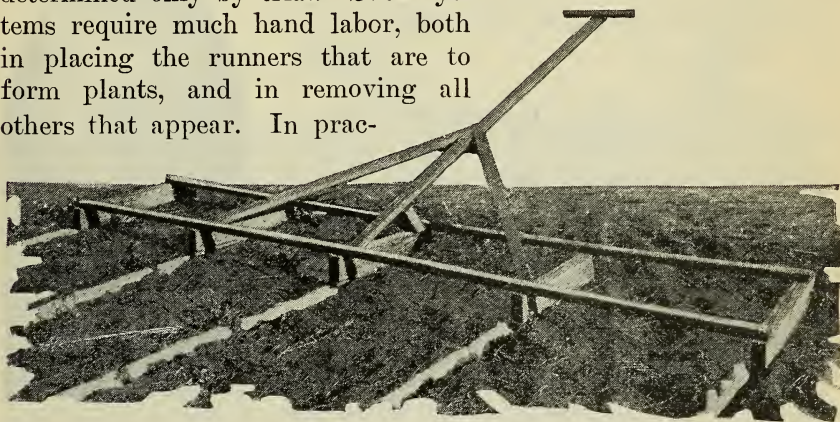


FIG. 7.—A homemade marker for laying off the rows. By marking across the first rows and setting the plants at the intersections, a horse cultivator may be used in both directions.

tice, special forms of the matted-row system are used chiefly when varieties of the highest quality are grown by market gardeners or in home gardens.

#### MARKING OUT ROWS.

Except when a machine planter is used, the position of the rows should be indicated by the use of markers, one type of which is shown in figure 7. This will make it possible to set the plants in straight lines. In using a horse cultivator there is less danger of disturbing the plants if they are properly placed, and less hand labor in hoeing will be necessary, since the horse cultivator can be gauged so that it will run close to the plants without disturbing them.



Fields are easier to cultivate when the plants are set in rows both ways, and if the plants are set  $2\frac{1}{2}$  feet or more apart in the rows, as shown in figure 6, *C*, a horse cultivator may be used in both directions until the runners begin to grow freely.

Where it is necessary to get surface drainage by making ridges on which to set the strawberries, the rows are indicated by the ridges; therefore no marking out of rows is necessary.

In marking out a field where the surface is irregular and steep enough to wash badly during heavy rains, the rows should be made to follow the contours of the land as far as possible, and they should run the long way of the field for convenience and economy in cultivation. (See fig. 3.)

#### NUMBER OF PLANTS REQUIRED FOR AN ACRE.

The best distance to plant varies with the system, the plant-making habit of the variety, the soil, the slope, the climatic conditions, the danger from white grubs, and the cost of labor.

Table III shows the number of plants needed to set an acre of ground when spaced in accordance with the systems commonly used.

Where there is little danger of loss of plants from any cause, only the number specified in Table III will be needed. If such danger exists, a larger number should be secured, as caring for a field which has many blank spaces will make the cost entirely out of proportion to the value of the crop obtained.



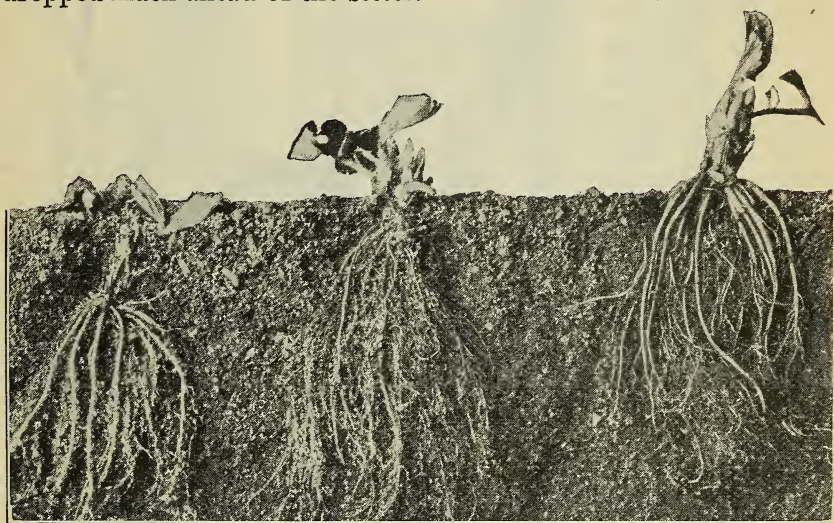
FIG. 8.—Boy dropping strawberry plants, showing a good way to protect them from the sun and wind. A fertilizer sack is slit across the front and the plants put in the bottom. Another slit near the top enables the dropper to hang it around his neck. (Photographed at Atmore, Ala., April 8, 1916.)

TABLE III.—Number of strawberry plants required to set an acre of ground when spaced at different distances apart.

Distance apart.	Plants to the acre.	Distance apart.	Plants to the acre.
2 feet by 1 foot.....	21,780	$2\frac{1}{2}$ feet by $1\frac{1}{2}$ feet.....	11,616
2 feet by $1\frac{1}{2}$ feet.....	14,520	3 feet by 2 feet.....	7,260
3 feet by 1 foot.....	14,520	3 feet by 3 feet.....	4,840
$3\frac{1}{2}$ feet by 1 foot.....	12,446	3 feet by 4 feet.....	3,630

## DROPPING THE PLANTS.

When being set by hand the plants should be protected from the sun and wind, so that the roots will not dry out. A basket or bucket may be used to hold the plants at the time of dropping, or they may be put in the bottom of a fertilizer sack which has been cut across one side with a slit across the top to hang the sack about the neck, as shown in figure 8. This protection from the sun and wind is especially important on clear, bright days, while on damp, cloudy days, less attention is necessary. Not only should the plants be protected when carried to the field and while in the field, but they should not be dropped much ahead of the setter.



P 21910 HP

FIG. 9.—Strawberry plants set at different depths in the soil. At the left is shown a plant set too deep, which will be likely to smother and die; in the center is one set at the proper depth and at the right is a plant set too shallow, which will dry out.

The supply of plants which has come from the nursery should also be protected from sun and wind. This may be done by covering them with a piece of wet burlap.

## SETTING THE PLANTS.

Plants may be set with the hand, with a dibble, spade, or punch, or with a machine made for the purpose. Whatever the method used, two things are of special importance in obtaining successful results: Setting the plants at the right depth and making the soil very firm about the roots.

The plants should be set so that the crowns are even with the surface of the ground after the soil has been packed about the roots. The proper depth for planting is shown in figure 9.



If the soil is not properly firmed about the roots, air gets to them and they are likely to dry out. Besides, such plants usually will start growth in a feeble manner or not at all. If the soil is thoroughly firmed, very little trouble will be experienced in getting plants to live. Some growers step on each plant after it has been set, to firm the soil properly. When this is done the instep should come over the crown of the plant in order to avoid injuring it.

#### Setting by hand.—

Setting by hand is satisfactory only in very loose soils. A wedge-shaped opening about 4 inches deep is made in the soil with one hand and the plant inserted with the other. The earth is then drawn about it and firmed. Plants may be set quite rapidly in this manner, but it is used in only a few localities, as the work is hard and the soil not often sufficiently mellow. It is chiefly used where the plants are set close together and those setting them do not have to move about much.

**Setting with a dibble or punch.**—In most localities an

opening is made in the soil with a dibble, trowel, or punch. Dibbles and trowels of different sorts used for this purpose are shown in figure 10. With one of these implements an opening 4 to 6 inches deep is made in the soil, the plant is inserted, and the earth pressed back firmly about the roots.

When a punch, such as is shown in figure 11, *D*, is used, one man usually goes ahead making the holes, another follows dropping the plants, and one or two others place the plants in the holes and draw the earth about them. The punch can not be used readily in soils

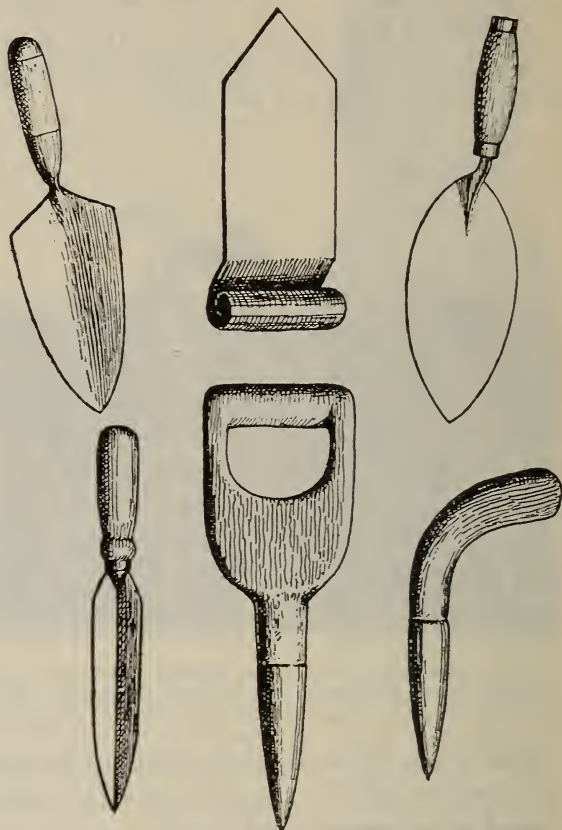


FIG. 10.—Different types of dibbles and trowels commonly used in transplanting strawberries.



which contain straw or stones, but is especially adapted for use in loose soils. The dibble, however, can be used in any soil that is properly prepared.

**Setting with a spade.**—A common method of setting the plants is with a spade. Two men form a setting crew. One inserts the spade



FIG. 11.—Different methods of setting strawberries. *A*, A "packer." The strawberry plant is forced into the ground with a paddle and the earth firmed around it with the packer, which is fastened to the paddle handle by clips and works up and down on it, as here shown. *B*, Setting a strawberry plant with a paddle. When the soil is very mellow the plants are dropped, the roots forced into the ground with the steel-tipped paddle shown, and the soil firmed with the foot. (Photographed at Pittsville, Md., June 3, 1916.) *C*, A punch and tongs used to set strawberry plants. A hole is made with the punch, the plant is picked up and placed in the hole with the tongs, and the earth firmed about it with the foot. *D*, A crew setting strawberries. The first man levels the top of the ridge or list, the second punches the holes, the third drops the plants, and the fourth and fifth men set them. (Photographed at Salisbury, Md., March 31, 1916.)

and by forcing it forward opens a hole. After the roots of the plant have been inserted, he withdraws the spade and with his foot presses the soil firmly about them. The second man carries the

plants and inserts them in the holes as they are made by the spade. Plants can be set rapidly in this manner, and the method is widely used.

**Setting with a paddle.**—The paddle shown in figure 11, *B*, is another tool often used to set plants. The plants are dropped in the exact place where they are to be set, and a man following presses the roots into the ground with the paddle and thoroughly packs the earth about them with his foot. Plants can be set very rapidly in this way, but the soil must be loose and friable.

A variation of this tool, called a "packer," is shown in figure 11, *A*. The plant is pressed into the ground with the paddle and the earth firmed around it with the packer.

**Setting with a punch and tongs.**—Another much-used method, shown in figure 11, *C*, is with a punch and tongs and is used more extensively for setting sweet potatoes than for strawberries. A hole is made with the punch, the plant picked up with the tongs and placed in the hole, and the earth firmed with the foot. One accustomed to the use of this instrument can set 10,000 plants a day with it, while an expert can set many more. Under favorable soil conditions it is easier to set 10,000 plants a day with this than to set 5,000 with a dibble or trowel.

**Setting by machine.**—On level land, planting machines used in trucking sections for transplanting tomatoes, cabbages, sweet potatoes, and the like, are often used to set strawberry plants. The soil should be moist, or water must be applied when the plants are set with this machine. Usually one man drives the machine and two others feed plants into it. About 30,000 plants, or 3 to 5 acres a day, can be set in this way.

The chief difficulty in the use of a planting machine is that it is hard to get all the plants set at the right depth. After some practice, however, intelligent droppers become so expert that practically all plants are set at the proper depth, with the roots straight down. A roller attached to the planter may be used to firm the soil, or a man may be employed to walk along the rows, firming the plants with his foot. When all conditions are favorable, especially where cool, moist weather may be depended upon for some time after the plants have been set, such a machine may be used very successfully, and the cost of planting will be comparatively low.

## CARE DURING THE FIRST SUMMER.

### REMOVING THE FLOWER STEMS.

Flower stems usually appear on strawberry plants soon after they are set in the field. Until the plants become firmly established after transplanting, the production of fruit is a severe drain on their



vitality; therefore, if the plants do not start well, or if a drought is occurring, the flower stems should be removed as they appear. Furthermore, if a very large number of plants is needed, or if the variety used does not naturally make many plants, the number of runner plants can be increased very materially by removing the flower stems as soon as they appear. If, however, the plants are thoroughly established in the soil and an especially large number of runner plants is not needed, the flower stems need not be cut off.

#### CUTTING RUNNERS AND THINNING AND SPACING PLANTS.

**Cutting runners.**—Under the hill system of culture the runners should be cut whenever they appear throughout the summer. A sharp hoe is ordinarily used for this purpose. Occasionally, a circular cutter about 8 or 10 inches in diameter, which cuts runners on all sides of the plants at once, is used. Much labor in cutting runners can be saved if two rolling cutters are attached to the cultivator and set just far enough apart to run between the rows. Most of the runners can then be cut at the time of cultivation. Such a cutter, however, can be used to advantage only where the soil is free from stones and straw.

**Thinning the plants.**—Under the matted-row system of culture it will usually be necessary to thin the plants in some way during the late summer and autumn. For this purpose, rolling cutters may be attached to the cultivator, so that all runners extending beyond a certain distance into the alleys will be cut off. Other surplus runners are removed when the field is hoed.

Where the matted row is 2 feet or more in width, growers sometimes use some method to thin the plants in addition to attaching rolling cutters to the cultivator. Thus, some use a bull-tongue plow with a point about 4 or 5 inches wide to run down the center lengthwise of each row, tearing up the center plants. This leaves the row cut in two parts, or in what might be called a double-matted row. Other growers sometimes run a spike-toothed harrow across the rows in late summer or autumn. The teeth should slant backward, so that only the plants which have not become thoroughly rooted will be torn up. The harrow, however, should be used only after careful trial, as there is some danger that too many plants may be loosened.

**Spacing the plants.**—Under the more intensive systems of culture, such as may be used in the home garden and in growing fancy berries, the runner plants may be spaced by hand rather than allowed to root at will. When this is to be done, the tips of the runners are covered with earth as soon as they begin to enlarge. The first runner plant should be placed between the mother plants in the rows. The next ones should be placed at the length of one runner out from the original row and on each side of it. There will then be three rows



of plants, and all other runners may be removed or additional runners may be rooted until a wide bed has been formed with the plants at least 6 inches apart. Thereafter, all runners should be cut off.

Sometimes it will be found cheaper to allow the runner plants to root at will until the middle of August. All superfluous plants are then dug out and the remainder spaced at equal distances apart.



FIG. 12.—A, Field of Aroma strawberries managed by the owner at Bowling Green, Ky. Note the absence of weeds and the presence of a good mulch. (Photographed May 26, 1913.) B, Field of Aroma strawberries adjoining the field shown above but managed by a tenant. The yield from this field was slightly more than 100 crates of 24 quarts each per acre, while from the field shown above nearly 150 crates per acre were harvested. (Photographed May 26, 1913.)

#### TILLAGE OF A NEW PLANTATION.

Tillage in newly set strawberry plantations must be very thorough in the early part of the season, in order to conserve moisture so that the plants can become established thoroughly in the soil, and later in the season to conserve moisture so that the plants can develop runners. Weeds and grass should be kept out of the fields, as it is very difficult to eradicate them after they have become established.

Many growers use the cultivator as often as once each week throughout the first season, and during periods of drought even more frequently. Hoeing should be done as often as it is found necessary to clean out all weeds between the plants. Tillage should be shallow near the plants, both because of the danger of loosening them in the soil and because if too deep the roots near the surface will be broken. The teeth on each side of the cultivator should be shortened, so they will not stir the soil near the rows to a depth of more than about 1 or 2 inches.

Tillage should be kept up until hard frosts occur. Many kinds of weeds continue to grow during the warm periods of late autumn, and start to grow very early in the spring. Therefore, where a mulch is used for a winter covering and to keep the fruit clean in the spring it is especially important that cultivation be continued as long as there is any chance of weeds growing. The field will then be free from weeds, and in the following year very few will have time to grow before the harvest season.

If weeds are not kept out, they will take the moisture needed by the strawberry plants. Weeds also interfere with the proper pollination of the blossoms by hindering the flight of insects from flower to flower, and many nubbins may result.

In figure 12 two adjoining strawberry fields which have been given different treatment as to cultivation and mulching are shown. From the field shown in the upper view all weeds were kept out, while in the adjoining field shown below many weeds can be seen. These weeds took the moisture supply and interfered with pollination, and as a result about 1,200 quarts more berries per acre were harvested from the first field than from the other.

### COMPANION CROPS WITH STRAWBERRIES.

In home gardens and where intensive cultivation is practiced, growers wishing to secure the greatest possible return from their ground often grow vegetables with strawberries as companion crops during the first summer after planting. Nearly all kinds of vegetables may be raised as companion crops, and the thorough cultivation given them will be sufficient for the strawberries.

Such crops as onion sets may be grown in the strawberry rows, as shown in figure 13, *A*, while quick-maturing plants, such as lettuce, radishes, peas, carrots, and beets, requiring similar culture, may be grown between the rows, as shown in figure 13, *C*. The berry rows are planted the same distance apart as under ordinary conditions and the vegetables are removed before the strawberry plants begin to spread over the ground to any extent.



When such crops as potatoes, beans, peas, and cabbage are grown with the strawberry, other systems are often followed. If cabbage or cauliflower is used, the plants may be set about 6 inches to one side of the rows of berries. The strawberry plants will be shaded to some extent by the leaves of the cabbage and cauliflower, but when these are removed during the summer the strawberries will spread over the ground and occupy the whole space.

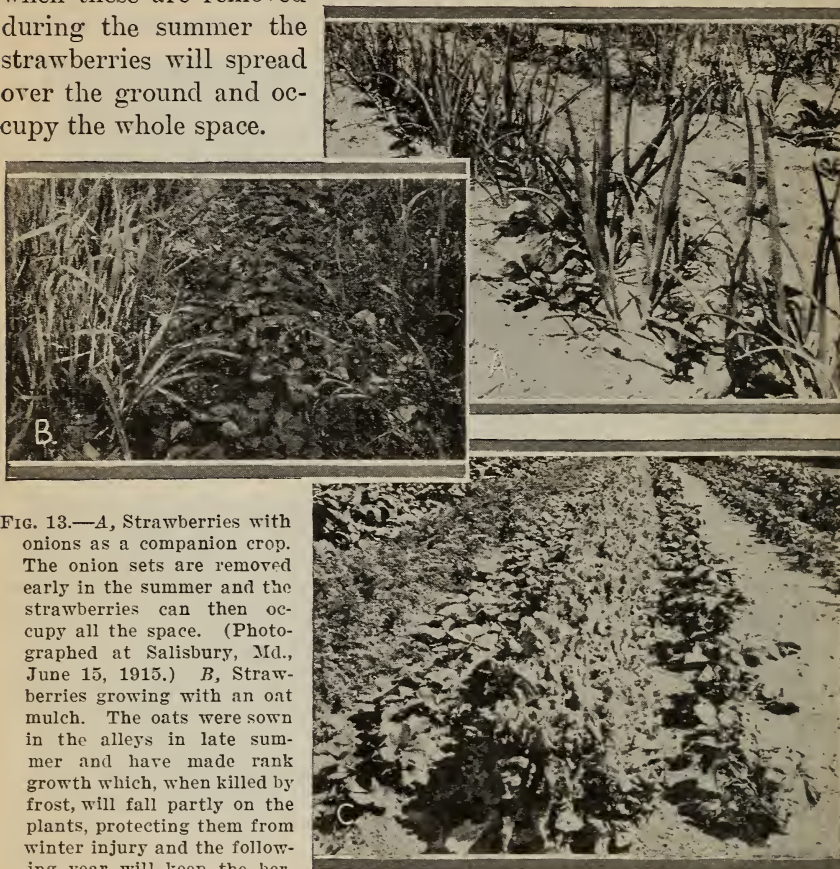


FIG. 13.—A, Strawberries with onions as a companion crop. The onion sets are removed early in the summer and the strawberries can then occupy all the space. (Photographed at Salisbury, Md., June 15, 1915.) B, Strawberries growing with an oat mulch. The oats were sown in the alleys in late summer and have made rank growth which, when killed by frost, will fall partly on the plants, protecting them from winter injury and the following year will keep the berries clean. (Photographed at Marlboro, N. Y., October 23, 1916.) C, Lettuce, carrots, and beets are being raised between the rows of strawberry plants, while radishes have already been harvested from the alley at the right. (Photographed at Three Rivers, Mich., July 8, 1915.)

When potatoes and beans are used as companion crops, the strawberry rows are usually set somewhat farther apart than in ordinary practice, and the companion crop is planted in the middle of the alleys between the strawberry rows. The berry rows should be at least 4 or 4½ feet apart, and only a narrow mat of plants should be allowed to form. The beans and potatoes are not removed until late in the season in northern districts, and the mat of plants therefore must be narrower than in more southern regions.



## THE STRAWBERRY AS AN INTERCROP.

Strawberries are sometimes planted in apple and other orchards. As a rule this practice is not to be advised, beyond possibly the planting of a row or two of berries along the center of the space between the rows of trees. This plan leaves free for cultivation a relatively wide strip on both sides of the tree rows. The strawberry plants, however, even when thus planted, should not be allowed to remain longer than 2 or 3 years.

Strawberries ordinarily are not cultivated in the spring until after the crop is harvested. This covers a period when good tillage is usually very important so far as the trees are concerned. Further, strawberries generally require tillage considerably later in the season than is advisable for fruit trees in the regions to which the directions in this bulletin apply. In other words, the tillage requirements of strawberries and of fruit trees differ to such a degree as to make them unsuited for growing together except as above noted.

## FERTILIZERS.

In general, strawberry growers in the northern United States are using less commercial fertilizer now than formerly. In many cases the additional yield resulting from the application of fertilizers was not sufficient to pay the cost, and their use was discontinued. In other cases growers have found that the crop from fields where fertilizers were applied was actually smaller than from those where none was used. Under such conditions those raising strawberries have, to a considerable extent, stopped using fertilizers until they could learn the needs of their particular soils.

**Fertilizer use a local problem.**—The use of commercial fertilizers and stable manure is governed largely by the same principles that apply to other crops. As soils vary greatly in the available plant foods which they contain, the use of fertilizers is largely a local problem, to be determined by each grower for his own conditions. This can be done by applying the different plant foods, nitrogen, phosphoric acid, and potash, separately, in different combinations, and in varying quantities, to small plats and keeping a record of the yields. In like manner different quantities of stable manure should also be applied to small plats, in order to test its value.

**How much fertilizer is needed?**—If certain facts are kept in mind they will help the grower in determining how much fertilizer to use. A good crop of berries will remove considerable quantities of nitrogen, potash, and phosphoric acid, but most soils are so well supplied with plant foods that strawberries could be grown indefinitely provided the physical condition of the soil is good. If, there-

fore, the soil is kept in a satisfactory condition by the addition of humus and by frequent tillage, and if the moisture supply is ample, many strawberry fields will need no fertilizers or stable manure.

**Phosphoric acid.**—Experiments have shown that in some soils the application of phosphoric acid has greatly increased the yields; in fact, this element of plant food is probably needed more often than any other in the northern part of the United States. Applications varying from 100 to 700 or 800 pounds per acre should be made in testing the possible value of this element.

**Potash.**—This has been found beneficial on some soils, but of no value on others. Different quantities, from 50 to 300 pounds per acre, should be used on test plats.

**Nitrogen.**—The use of nitrogen has been found profitable in the growing of certain varieties, especially the Marshall, Glen Mary, Belt (*William Belt*), and Chesapeake. These, as well as some other varieties, seem to need the stimulating effect of this fertilizer in early spring. Some growers use nitrate of soda for this purpose about a week after the plants have started to grow, applying 50 to 200 pounds per acre. This application is made in the spring of each year following the one in which the strawberries were set. When nitrogen is applied to plantations of the naturally strong-growing sorts, the foliage may become too rank, the berries may be softer, and the yield less than if no nitrogen were applied. Nitrogen, therefore, should be used commercially only after careful tests have demonstrated its value.

**Stable manure.**—Manure is often used in place of nitrate of soda or in addition to it. When needed, it should be applied in the autumn in the form of a mulch, and it will help to protect the plants from heaving and from severe winter weather. The nitrogen in the stable manure helps to stimulate a heavy leaf growth. In addition, stable manure contains the other elements of plant food, as well as large quantities of humus. Amounts varying from 8 to 50 tons to the acre are used by commercial growers, although applications of 15 to 20 tons are most common. Tests, however, should be made by each grower to determine the best quantities for his conditions.

**When to apply fertilizers.**—The time of applying fertilizers varies greatly. Some growers apply potash and phosphoric acid before or at the time of setting the plants; others make a portion of the application then and the rest during early summer. Conditions vary so greatly that no rule can be given, and each must determine for himself when to apply these elements.

When potash and phosphoric acid are used before the plants are set, they may be broadcasted or drilled in where the plant rows are to be. Later applications may be drilled in along the rows or scat-

tered on top of the plants. In the latter case, a brush should be dragged over the rows to remove the fertilizer from the leaves in order to prevent burning the foliage. When a plantation is to be renewed, the potash and phosphoric acid should be applied at the time of renewal.

### USE OF LIME.

Experiments have shown that lime has a harmful effect on the roots of strawberries. Sometimes, however, where the soil is in poor physical condition, it may pay to use small quantities of it to improve soil conditions. However, it should be applied broadcast considerably in advance of setting the plants. If legumes are used in a rotation, and lime is needed, it will be best to apply it before the green-manure crop is grown.

### IRRIGATION.

In many sections of the northern United States, severe droughts occur during periods when they cause considerable loss to strawberry growers. Almost every season droughts of greater or less severity occur in all localities, and if these come during the fruiting season, the berries do not reach full size and a large part of the crop may be too small to market. Where such conditions frequently occur during the period when the fruit is developing, irrigation may be desirable. Where the installing of an irrigation system is practicable the water needed for the establishment and proper growth of the young plants and for the development of the runners is very largely under the control of the grower. Furthermore, if a drought occurs early in the growing season, the field may be irrigated regularly and a full crop secured.

To make irrigation practicable, there should be an abundant supply of water near the field to be irrigated. The crop must be grown under an intensive system of culture, as the cost of installing an irrigation system is considerable, and materially increases the investment on which the grower must make adequate returns if his strawberry enterprise is to be successful financially.

The installation of an irrigation system is a permanent improvement on the farm, but it should not be made until the possibility of securing the labor necessary to grow intensive crops has been carefully considered and is fully assured.

### OVERHEAD IRRIGATION.

At the present time, an overhead sprinkling or spray system of irrigation is used quite extensively in southern New Jersey, while smaller areas irrigated in this way in nearly all of the Northern



States have been found profitable. Surface irrigation has been used very little in these States; this method can be employed only on fields which have gentle, uniform slopes and either a rather heavy surface soil or a heavy subsoil at a slight depth below the surface of the ground. The spray system, however, has no such restrictions.

In figure 5, *A* and *B*, are shown overhead spray irrigation systems in New Jersey, and *C* illustrates this system as used in Michigan. In the New Jersey fields shown the Chesapeake strawberry is grown. Crops of 8,000 quarts and more per acre of this variety have been obtained under irrigation when not more than 3,000 quarts were secured on similar soil in an adjoining field not irrigated. The Chesapeake has been found to respond especially well to irrigation.

As the cost of a system of overhead spray irrigation will range from \$80 to \$250 or more per acre, growers whenever possible should obtain information concerning the experience of others in the use of irrigation before investing heavily. In many cases, however, irrigation will be found very profitable.<sup>1</sup>

#### SURFACE IRRIGATION.

For many home gardens, as well as in commercial plantations, surface irrigation will be found satisfactory. The rows should not be more than 200 to 250 feet long, and furrows should be made in the alleys to direct the flow of the water. Surface irrigation is better adapted to silt and clay than to sandy soils.

#### MULCHING.

##### ADVANTAGES OF MULCHING.

In the northern part of the Middle West all varieties must be protected in the winter against the severe drying winds which occur in those regions. Where the ground has a covering of several inches of snow throughout the winter, a mulch is not ordinarily needed for protection against the cold. In regions of heavy snowfall, however, the plantation often needs a mulch to keep the ground from freezing and thawing in early winter and in the spring. Clay soils heave when they freeze and thaw, and the plants may be thrown entirely out of the ground, or their roots may be broken so that they will dry out and die. A mulch also conserves moisture in the spring, and in certain localities and under some conditions the crop may be increased from one-third to one-half by its use. The mulch also helps to keep down weeds, which interfere greatly with the pollination of

<sup>1</sup> U. S. Department of Agriculture Bulletin 495, entitled "Spray Irrigation," which may be obtained free upon application to the Secretary of Agriculture, gives detailed information on the installation of spray irrigation equipment.

the flowers and with picking. During the harvesting season, the berries are kept clean and are protected from the soil when rains occur. A heavy mulch may delay the ripening season for several days.

#### DISADVANTAGES OF MULCHING.

The disadvantages of mulching are that when unseasonable frosts occur in the spring the blossoms may be more severely injured where a mulch is used than where it is not. It is often several degrees cooler at the surface of the ground where there is a mulch than where there is none. Another possible disadvantage is that the mulch sometimes contains weed seeds, which germinate and so add to the expense of caring for the plantation. Where suitable material is difficult to secure, the application of a mulch may be very costly.

#### MATERIALS FOR MULCHING.

Among the materials used for mulching are stable manure, straw, pine needles, wild hay, and crops grown for this special purpose. Where such varieties as the Marshall, Glen Mary, and Belt (*William Belt*) are used, which need stable manure to force them into rapid growth in the early spring, strawy stable manure is considered most desirable. This should be applied late in the autumn after the ground has begun to freeze but before it has frozen more than 1 to 2 inches deep; 10 to 20 tons per acre may be used. Stable manure is also used to mulch the Progressive and the Chesapeake, and even larger quantities may be used profitably with these sorts. In parts of New Jersey where the Chesapeake is grown under irrigation, many use 20 to 30 and even 40 tons of stable manure to the acre. Some kind of straw is perhaps more commonly used than any other mulching material, and wheat, rye, oat, and buckwheat straw mulches have been found satisfactory. Such material, however, should be as free as possible from grain and weed seeds, as these sometimes start to grow in the spring and become troublesome. From  $2\frac{1}{2}$  to 5 or 6 tons of straw or 1 to 3 tons of marsh hay per acre are ordinarily used. Figures 5 (*A* and *B*) and 6 (*B*) show fields mulched with stable manure and straw.

Wild hay, ferns, and pine needles are often used and are very satisfactory where such material may be secured at small cost.

**Growing a mulch.**—The mulch may be grown in the strawberry field if it can not be secured readily and cheaply elsewhere. Oats are most commonly used for this purpose and should be sown in the alleys between the strawberry rows in August or September (about 50 days before a killing frost is expected) at the rate of 1 to 2 bushels per acre. They should not be sown too thickly or too close to the strawberry plants, as there is danger of smothering them.



The oats, which should have reached a height of 1 to 2 feet if they have 50 days of growth, are killed by the first hard frost and form a good mulch between the rows and over the plants. Weeds are crowded out by the oats, so that less cultivation in the autumn is needed. Figure 13, *B*, shows strawberries with oats grown as a mulch. A mixture of kafir and sorghum or of oats and sorghum may be used instead of oats and is preferred by some.

#### TIME TO MULCH.

In the North Central States, where the soil is likely to freeze and thaw several times during the winter or where cold drying winds



FIG. 14.—*A*, Mulching a strawberry field at Bowling Green, Ky., with wheat straw. The straw is drawn on usually after the ground is frozen. *B*, A strawberry field at Bowling Green, Ky., shown when partly mulched. The straw was thrown off the wagon in windrows, as shown, and spread by hand over the rows of plants.

occur, the mulch should be applied as soon as the ground is frozen enough to allow driving over the field. In some localities growers have found it unsafe to await freezing weather, because of the danger of severe storms or heavy falls of snow which remain throughout the winter, and they put the mulch on as soon as active growth has ceased. Where it is desirable to delay the ripening season, the mulch may be applied in early spring before the snow has melted. The mulch will delay the melting of the snow and retard the growth of the plants and the ripening season for several days.

In the more southern regions, such as Delaware, Maryland, Kentucky, southern Illinois, Missouri, and southward, where the ground



freezes late in the autumn, mulching may be delayed as late as December.

The mulch should be scattered over the fields so that some will fall on the plants, but more of it between the rows. Figure 14 shows how the mulch is applied. In the spring the plants will grow up through the straw, and the berries will thus be kept clean. If the mulch is very heavy, it may be necessary to go over the fields at the time growth starts and rake some of it into the alleys between the rows.

#### REMOVING MULCH.

In most localities where the land is fairly free from weeds or where the kinds of weeds that occur do not start growth early in the spring, the mulch may be left on the plantation until after the harvesting season. Where there are weeds which grow rapidly in early spring, either the mulch should be removed from the alleys to the tops of the rows and the cultivator run through the alleys once or twice and then the mulch returned to the alleys, or the mulch should be left in place and the weeds pulled by hand. Where the weeds are not too abundant the latter method may be more satisfactory. Although cultivation or the pulling of weeds may disturb the roots of the strawberry plants to some extent they will suffer less than if compelled to compete with the weeds for moisture, and it is much better to cultivate, hoe, or pull the weeds than to leave them to grow in the fields. In all cases, therefore, the weeds should be removed, even up to the time when picking commences. If the weeds are pulled when small the roots of the strawberry plants will be disturbed less than if weeding is neglected until they become large.

#### PICKING.

The different varieties of strawberries vary somewhat in the degree of maturity at which they should be picked. Varieties with soft flesh must be picked before they are very ripe, in order to get them to market in good condition. Firm varieties, however, may be left on the plants until thoroughly ripe, and will have a better appearance on the market than those picked when not fully ripe.

Varieties also differ greatly in the length of the picking season. Many, like the Gandy, have a very short season of 10 days or two weeks, while others, like the Campbell, have a relatively long picking season, which may last four weeks or even longer. The grower must plan his work according to the habit of the variety.

Varieties differ also in the frequency with which they need to be picked. Usually the berries should be picked every other day, but certain varieties may be left three days between pickings, while still others should be picked daily.

## KEEPING AFTER PICKING.

The length of time that the fruit will stand up after it has been picked depends upon the variety, the degree of ripeness, the care with which it is handled, and the temperature of the berries at the time they are picked and at which they are held after picking. Experiments have shown that for each rise in temperature of about  $15^{\circ}$  F.,



FIG. 15.—A, Two 6-quart carriers filled with Chesapeake strawberries. These carriers are commonly used in picking berries. (Photographed at Bridgeton, N. J., June 10, 1916.) B, Carriers holding 1-quart baskets used to carry strawberries from the field to the packing house.

the life of the berry, other things being equal, is decreased one-half; that is, if the strawberry will keep for 8 days in good condition at a temperature of  $40^{\circ}$  F., it will keep for only four days at a temperature of  $55^{\circ}$ , only two days at a temperature of  $70^{\circ}$ , and only one day at a temperature of  $85^{\circ}$ . If the berries are picked in the early morning when they are relatively cool, and put at once in the shade, they will keep much better and have a much better appearance on the



market than if picked at midday when the berries are warmer, or if left in the sun after picking.

Carriers used in picking berries are shown in figure 15. The 6-quart carrier illustrated (*A*) is commonly used for picking, and the 10 or 12 quart carriers shown (*B*) are used to carry the berries to the packing house. Such carriers are used only when the packing is done at some little distance from the place where the berries are being picked. In smaller fields, where the packing house is located within a short distance of the pickers, each picker usually carries his berries to it, and the larger carriers are unnecessary.

### DURATION OF THE PLANTATION.

The number of crops harvested from a plantation varies greatly in different parts of the country. In some localities, one crop only is harvested, and then the field is plowed up; in others two, three, or even more crops are secured. The length of time the plantation should be kept depends upon the variety, the number of weeds in the field, the character of the soil, and the comparative cost of renewing an old plantation and setting a new one.

Certain varieties of strawberries produce their largest crop the first year after setting, while others yield a larger crop the second and third years. Those growing varieties which often bear a larger crop the second season than the first, such as the Klondike in Delaware and the Gandy in New Jersey, should continue their plantations for at least two years. From plantations of some varieties, such as the Aroma, for example, very large crops will be secured for a number of years, and if possible, fields of such varieties should be kept for several seasons.

Where certain kinds of weeds, such as white clover, purslane, chickweed, and crab-grass, are prevalent, it may be necessary to plow up the plantation after only one crop has been obtained. When white clover starts in a plantation, it is almost impossible to eradicate it, and the cost of eradication is usually much greater than that of setting out and growing a new plantation. The same is often true when some other weeds become established in the strawberry field.

In many localities where the soil is not well supplied with humus, one crop only should be harvested before the plantation is renewed. The yields after the first year are too small to be profitable. Ordinarily, in such sections, it will pay to turn under green-manure crops or apply stable manure before the strawberries are set, in order that the plantation may be kept profitable more than one year.

The length of time that a strawberry plantation should be maintained depends, therefore, upon several conditions. Wherever intensive culture is practiced, the plantation usually should be kept for



at least three crops, and sometimes for 5 or 6 crops or as long as it gives paying returns. The cost of renewing a plantation under ordinary conditions is less than the cost of setting out the plants on a new field and taking care of such a plantation until midsummer, the time when an old plantation is renewed.

## RENEWING THE PLANTATION.

### MOWING THE FIELD.

In renewing a plantation, the field should first be mowed over. Fields of plants trained to the matted-row system are usually mowed



FIG. 16.—Strawberry plants (at the right) which have just had their tops cut off. Immediately after the crop has been harvested the tops should be cut off with a hoe or a mowing machine. (Photographed at Vashon, Wash., August 7, 1916.)

by machine, while the foliage of plants under the hill system may be cut off with a scythe, sickle, or sharp hoe, as shown in figure 16. In the extreme North, where the growing season is short, the foliage should be mowed as soon as the crop has been picked. Where the growing season is longer, the mowing may be delayed for several weeks. Thus, in a region like Delaware, where there is a comparatively long growing season, the foliage need not be cut until some time in August.

If injury from insects and diseases is not serious, the mulch and leaves should be turned under, if possible. This will increase the

humus content of the soil, and put it in better condition than if burning is practiced. When the mulch is very heavy, however, it may be necessary to remove a part of it before plowing. The mulch may be raked up and stacked for use the following year if it is not too much decayed. In that case, only the strawberry foliage that has been cut off is plowed under.

#### BURNING THE LEAVES AND MULCH.

Where insects and leaf-spot diseases are prevalent, growers prefer to burn the foliage and the mulch without removal from the field. It is then easier to thin the plants and narrow the rows than if the mulch and leaves are left on the ground. In some localities and with certain varieties, as soon as the foliage has dried, the mulch should be raked on top of the rows, and when a good breeze is blowing in the direction in which the rows run, the fire should be started on the windward side. When burned in this way, the fire will pass quickly and the roots and crowns of the plants are not likely to be injured except as noted below.

**C**AUTION.—*The foliage and mulch should not be burned when the ground is very dry or when the mulch and leaves are damp. Moreover, as the crowns of some varieties are more tender than those of others, a test should be made before burning over a field of a variety not previously subjected to such treatment.*

In some localities the Dunlap and other varieties are severely injured if the mulch is over the plants when burned. Where such sorts are grown, the leaves and mulch should be raked into the alleys between the rows before burning.

A few growers practice burning over their fields in early spring before growth starts, and they in this way remove diseased foliage and insect eggs. If the leaves are not dry enough to burn quickly, coal oil may be sprayed on the plants to hasten it. The mulch, of course, should be removed before the field is burned over, and should be replaced afterward.

#### THINNING THE PLANTS.

When renewing a plantation, it is desirable to reduce the number of plants in the matted row after the crop is harvested, so that new runner plants may develop. The amount of thinning necessary will depend upon the variety, and to some extent upon the season and



the soil. If the variety raised is one that will make a large number of runner plants later in the year, the row should be reduced to 6 or 8 inches in width, and the plants in this row thinned so that they are at least 10 inches apart. If the variety does not make many runner plants in late summer and autumn, the row should be left 12 or 15 inches wide and the plants about 10 inches apart.

**Thinning with plow and harrow.**—To reduce the width of the row either one side or a part of both sides should be plowed up. Usually it is best to plow up one entire side of the row, and also the old plants in the middle. This will leave only the young plants on one side. These remaining plants are then thinned by running a spike-tooth harrow or a cultivator across the rows once or twice and then once down the row. The weaker plants are torn up and the ridges made by plowing up one side of the row are leveled. Hoes may then be used to thin out the remaining plants, if they are still too thick. The crowns of the plants that are left are usually covered with an inch or two of soil. Within two or three weeks the plants will have sent out new foliage, and the field will have the appearance of a young plantation.

In many cases the location of the rows is changed by plowing up one side of each one year and having the remaining plants set runners in the alleys. The second half of the old row of plants is plowed up the following year, so that by the third year the rows run where the alleys were the first year.

If the narrow matted-row system is used it may be necessary to reduce the width of the rows very little, if at all. A shovel cultivator may then be used to plow across the rows, leaving the plants in small clumps about 24 inches apart. Later in the summer the runners will fill the spaces thus plowed up and make continuous matted rows by winter.

### FALL-SET PLANTS FOR FANCY FRUIT.

In New England, New York, New Jersey, and in some other parts of the North, gardeners sometimes in August or early in September set those plants which produce a crop the following year. When this practice is followed the plants used in setting must be large; they must have good root systems, and must be set in rich moist ground. The plants are usually grown by the hill system, two rows of plants being set close together, as shown in figure 5, *B*. They should be set much closer than when planted in the spring, sometimes as close as 4 to 6 inches apart in rows 3 feet apart. Such plants ordinarily should be mulched with strawy manure in the autumn, and given the best of care. They will produce very large fruit the following year, a few days later than the usual season for

the variety. When the Chesapeake is used and irrigation is given as needed, as large crops are produced occasionally as if the plants were set in early spring and grown for a full year, but the average yield from plants grown in this manner will not be as large as from spring-set plantations.

### FROST PROTECTION.

Where the strawberry is frequently injured by unseasonable frosts in the spring, various methods of protecting the flowers may be used.

**Protection with mulch.**—Where material for mulching is fairly cheap it may be raked from the alleys to the top of the rows the day before a freeze is expected. This involves considerable hand labor and is costly, but will sometimes prove profitable. It is possible to delay the blossoming period a few days by covering plants with a heavy mulch in the autumn and leaving it on as late as possible. When the weather becomes warm and growth has begun, part of the mulch should be placed in the alleys and the remainder left over the plants.

**Water protection.**—Where overhead spray irrigation is practiced it is possible to start sprinkling late in the evening and continue until after danger from frost is over the next morning. This will protect the plants very largely from frost injury.

**Heat protection.**—Smudging and heating are occasionally practiced. The strawberry plant, however, is close to the ground, where the temperature is lowest, and it is difficult to raise the temperature of the air next to the plants effectively. If heaters are used, 125 to 150 per acre will be needed to protect the plants from a frost, which is 6 to 8 degrees below the freezing point at the surface of the ground. If fires are used to protect the strawberries from frosts, many small fires should be built throughout the strawberry field, or at the lower side if it is on a slope.

**Plant everbearing<sup>1</sup> or late-blooming sorts.**—Late-blossoming sorts may be selected in some cases or, if frost is expected very late in the spring, the everbearing varieties should be grown. If the first blossoms of these are killed they will send out a new set of flower buds and produce a crop of fruit in due course provided other conditions are favorable.

### PROPAGATION.

Strawberries are propagated commercially by the use of runner plants only, but they can be propagated from seed and by dividing the crowns. Most plants raised from seed will bear fruit inferior

---

<sup>1</sup> See Farmers' Bulletin 901, entitled "Everbearing Strawberries," which may be obtained free on application to the Secretary of Agriculture.



to that borne by the parent plants, and none of the seedlings may resemble the parents closely. Dividing the crowns of strawberry plants to make new plants, is too slow and expensive for ordinary use. Propagation by runner plants offers, therefore, the only practicable method of securing large numbers of plants of a desirable variety.

**Plants for spring setting.**—After a grower has once established a strawberry field, he usually can procure plants for setting from his bearing plantation. For spring planting, the best practice is to use the younger plants along the sides of the alleys in the matted rows. This will secure plants which rooted late the previous autumn, and which will be more likely to start a vigorous growth on transplanting than the older plants which are ready to start fruit bearing. In digging plants, the roots of those which are to remain should be disturbed as little as possible.

**Plants for fall setting.**—For August and September planting growers should select



FIG. 17.—A Marshall strawberry plant grown from a runner in a "plunged" pot. This plant is larger than the average of those produced in August or September. It may be planted with little or no disturbance of the roots, and will bear fruit the next season.

P 21342 HP

plants having the best root systems and the largest crowns obtainable. Such plants will produce larger crops the following year than weaker plants.

Both pot-grown and field-grown plants are used for late summer planting. To raise pot-grown plants, small pots filled with rich earth are plunged into the ground near the parent plants, and the first runners to appear are made to root in them. These potted plants can be transplanted with the least injury to the root systems and with a likelihood of best results the following year. (See figure 17.)

If the plants are to be dug in the field where the runners have rooted in the ground, those with the thickest crown and best root systems should be selected, and the greatest care must be used to protect their roots from injury by the sun or drying winds.

Strawberries raised on clay soil are difficult to transplant. Those who have no other soil often prefer to procure plants from other localities rather than attempt to use their own stock. Sandy soil should always be chosen for a strawberry-plant nursery.

### PLANTS WITH PERFECT AND IMPERFECT FLOWERS.

Strawberry varieties in cultivation have two types of flowers, perfect and imperfect. Figure 18 shows the difference between these two flowers. It will be noticed that the perfect flower has both pistils and stamens, while the imperfect one has only pistils. To produce berries, pollen from the stamens must be carried by wind or insects to the pistils. Therefore, varieties having perfect flowers

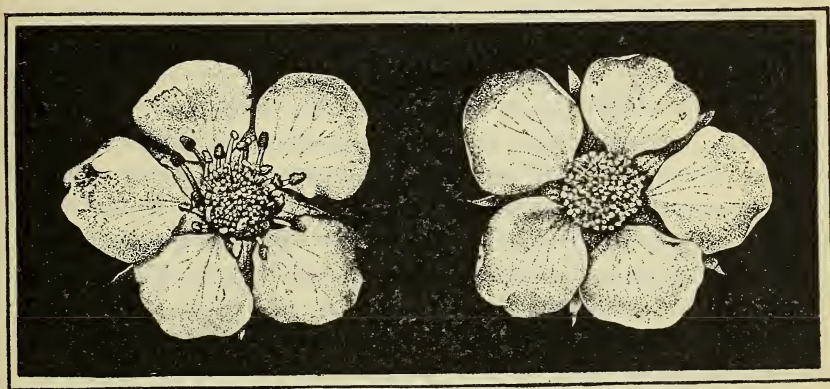


FIG. 18.—A perfect or staminate strawberry blossom (at the left), having both pistils and stamens, and an imperfect or pistillate blossom (at the right), having pistils but no stamens. Imperfect varieties will not produce fruit unless grown near plants having perfect or pollen-producing blossoms.

will produce a crop of fruit when set by themselves, while those having imperfect flowers will not bear fruit unless planted near perfect sorts.

Most of the varieties cultivated extensively at the present time are the perfect sorts. A few very productive sorts have imperfect flowers, but they are not more productive than many perfect sorts. Imperfect sorts are widely grown in certain localities where the weevil is very destructive, because that insect feeds on the immature pollen found in the buds of perfect-flowered sorts, and leaves varieties having imperfect flowers almost untouched.

Whenever imperfect varieties are planted, there should be at least one row of a perfect variety to every three rows of the imperfect one, and it is usually better to plant one row of the former to every two of the latter. A few growers prefer to mix the plants of both sorts in the same row, but as varieties differ in their shipping quality and in their shape, size, and color, and as the markets prefer



to have each variety in a basket by itself, this practice should be discouraged.

Pollination is influenced not only by the variety, but by the weather conditions, by the amount of moisture in the soil, and by weeds. When rainy weather occurs at blossoming time, some varieties, such as the Glen Mary, which are not strongly staminate, do not develop sufficient pollen to make them fully self-fertile. These sorts should be interplanted with some strong pollen-producing variety. In seasons of extended drought, the plants may not be able to get sufficient moisture to develop the flowers properly, and small berries, frequently poorly pollinated, result.

### VARIETIES.

The variety to be planted in any locality will depend upon the climate, the soil, and the purpose for which the crop is to be grown. In the early history of the strawberry industry in this country, when there were fewer varieties, a single sort with recognized superiority over others was often grown nearly throughout the United States. With the development of the industry, however, varieties adapted to the climate of special regions have been produced. In the South the Missionary and Klondike are almost the only varieties grown. In the Hood River and White Salmon regions of Oregon and Washington the Clark is preferred to all other sorts. In other localities certain varieties especially adapted to the local climate and needs have become dominant. In the northeastern part of the United States, however, the climatic conditions vary greatly within comparatively short distances, and because of this a larger number of varieties are grown. Moreover, the soils in that part of the United States are variable and many varieties are more or less restricted in their soil adaptation.

**Special-purpose varieties.**—As the strawberry industry has developed, varieties particularly adapted to special purposes, also, have been introduced. Some bear firm berries which are especially adapted to long-distance shipment. Others have berries which are large, attractive, and of the best quality but which are too soft for long shipment and are therefore suitable for the local market and for home use only. Still other varieties which have a dark-red, firm flesh and a brisk subacid or acid flavor are adapted to canning and to the soda-fountain trade.

Anyone selecting varieties of strawberries should choose those suited to the purpose for which they are to be grown and especially adapted to his particular soil and climate. The experience of growers in a community is one of the best guides in selecting the most profitable varieties for planting there. For general-market purposes, however, varieties which are found to be widely adapted should ordi-

narily be grown. Plants of such varieties can be secured more readily than plants of those which are restricted in their adaptation, and the well-known sorts are preferred in the markets.

**Varieties for market.**—When raising berries for the general market, only one or two varieties should be grown, as buyers prefer to secure full carloads of one variety rather than carloads of mixed varieties which may vary in their shipping qualities and may have different colors, shapes, and flavors. In most of the larger shipping regions, only one variety or at most two or three varieties are grown.

Those who grow strawberries for the local market often wish a succession of ripening throughout the season and may grow as many as three or four sorts to cover the very early, medium early, mid-season, and late periods of ripening. In the home garden, also, several varieties should be grown, so that a succession of fruit through a long season may be secured.

### USES OF THE STRAWBERRY.

Many million dollars' worth of strawberry products are manufactured each year. Among the more important of these are preserves, jams, essences for flavoring candies and for use as flavoring extracts, sirup for soda fountains, and crushed fruit for flavoring ice cream and sauces. Large quantities of strawberries are also canned. The varieties commonly used for these purposes are deep red to the center, acid (with a strong strawberry flavor), and so firm fleshed that they will not break to pieces in cooking. Among the best for such purposes are the Klondike, Wilson, and Clark. In localities to which these sorts are not well adapted, the Parsons, Superior, Marshall, Warfield, Dunlap, Gandy, Joe, Missionary, and others are grown.

Many factories for utilizing the strawberry have been erected in the large producing areas. Other factories, to which the fruit is shipped, are located in the cities. The managers of these factories have found that the strawberry is in the best condition for use if picked while very firm, even before it is fully ripe, and made up the same day. The factories located in the producing areas, therefore, have an opportunity to make the finest product. In utilizing strawberries in the home or for the market, the experience of those concerns in selecting certain varieties and in using firm berries the same day they are picked should be followed. The directions for making strawberry products given on the following pages are based largely on the experience of commercial concerns.

### CANNING.

Sort out defective berries; wash and hull; pack the jars level full with sound, firm berries not fully ripe; fill the jar with a sirup of 30° Balling density made by boiling 3 pounds 9 ounces (8 cups)



of sugar in 1 gallon (16 cups) of water until the sugar is dissolved, and then process<sup>1</sup> pint jars 10 minutes and quart jars 12 minutes. To make an especially fine product in the home, heat the smaller and softer berries and strain the juice from them, using this juice with sugar to make a sirup. Pour this sirup boiling hot over the berries in the jars, and process as directed above. Instead of processing 12 minutes in the usual way, the cans may be placed in a kettle of boiling water and the kettle covered tightly. It is at once removed from the stove and allowed to cool before the jars are removed from the water. Commercial canners wash the berries after instead of before hulling, and use sirups varying from 30° to 60° density; for pie stock they often can strawberries without the use of sugar.

#### PRESERVING.

**Recipe No. 1.**—Sort out defective berries; wash and hull. Make a sirup by adding 35 ounces (5 cups) of sugar to one cup of water and bring to the boiling point. Add 2¾ pounds (almost 2 quarts) of berries to this hot sirup; boil until a candy or chemical thermometer registers 222° F., or until the sirup is thick. Pack the jars level full of berries and fill with the sirup. Process the jars at simmering (188° F.) for 30 minutes.

**Recipe No. 2.**—Sort out defective berries; wash and hull. Add three-fourths of a pound of sugar to each pound of berries; let them stand over night in a warm room; drain off the juice and reduce by boiling until it thickens into a sirup; pack the fruit in jars and pour the hot sirup over it; let it stand for 24 hours; heat slowly to the boiling point in a water bath; remove from the water and seal.

**Recipe No. 3.**—Sort out defective berries; wash and hull. Heat the smaller and softer berries and strain the juice from them. To 1½ pounds (almost 3½ cups) of sugar add 1 cup of the berry juice; bring to the boiling point; then cool. When cool, add the berries, a few at a time; heat slowly to the boiling point and cook until the berries are bright and transparent (106° C., or 223° F.); cool and pack in cold sterilized jars. Process pint jars at simmering for 30 minutes.

#### SUN PRESERVING.

**Recipe No. 1.**—Select sound, ripe berries; wash and hull. Prepare a sirup by adding three-fourths pound (1¾ cups) of sugar to each pound of berries and let them stand for several hours in a warm room to extract the juice. Then drain off the juice and heat it.

---

<sup>1</sup> To process, place the jars in a water bath on a rack which allows circulation of water beneath them. Have the water about the same temperature as the contents of the jars. The water should be about an inch over the tops of the jars. Have the covers on the jars, but not tightened. Note the time when the water begins to boil, and keep boiling steadily for the time required, then remove the jars promptly and tighten the covers.

When it boils add the berries and cook 5 minutes. Remove from the fire, spread in shallow platters, cover with glass, and put in the sun while hot. Leave in the sun until the sirup thickens; then put in sterilized jars and cover with hot paraffin.

**Recipe No. 2.**—Select sound, ripe berries; wash and hull. Use three-fourths pound ( $1\frac{5}{7}$  cups) of sugar to 1 pound of berries; put the berries in a kettle in a warm place until the sugar is dissolved. Bring to a boil, remove from the fire, spread on shallow platters, cover with glass, and put in the sun while hot; leave in the sun until the sirup thickens; then put in sterilized jars and cover with hot paraffin.

#### STRAWBERRY JAM.

Sort out defective berries; wash and hull. Mash thoroughly and add three-fourths pound ( $1\frac{5}{7}$  cups) of sugar to each pound of berries; cook slowly for 20 minutes or until the jam is of the desired thickness. Pack in sterilized jars; cover with paraffin or seal after processing for 5 minutes in a hot-water bath.

#### COMBINATIONS WITH OTHER FRUITS.

In making preserves and jams, strawberries are often combined with other fruits. Such products are preferred by many to those made of strawberries alone. Among the combinations considered most desirable are strawberry-raspberry, strawberry-pineapple, strawberry-rhubarb preserves and strawberry-currant and strawberry-gooseberry jams. Although these fruits may be combined in any proportion, the following procedure will be found desirable.

**Strawberry-raspberry preserves.**—Crush, heat, and extract the juice from raspberries; use 1 cup of raspberry juice and  $2\frac{1}{4}$  cups (almost 1 pound) of sugar for each quart of sound, hulled strawberries. Proceed as for strawberry preserves.

**Strawberry-pineapple preserves.**—Use 1 pound of grated or chopped pineapple, 2 pounds of strawberries, and  $2\frac{1}{4}$  pounds (5 cups) of sugar. Bring the pineapple and sugar slowly to the boiling point and boil for about 10 minutes; then add the strawberries and cook slowly until thick; put in sterilized jars and seal.

**Strawberry-rhubarb preserves.**—Use 1 quart of chopped rhubarb and  $1\frac{3}{4}$  pounds (4 cups) of sugar to one-third quart of strawberries. Proceed as for strawberry preserves.

**Strawberry-currant jam.**—Use three-quarters of a pound ( $1\frac{1}{7}$  cups) of sugar and 1 pint of currant juice to 4 pounds (about  $2\frac{3}{4}$  quarts) of strawberries. Proceed as for strawberry jam.

**Strawberry-gooseberry jam.**—Use 2 cups of gooseberry pulp and  $4\frac{1}{2}$  cups of sugar to 2 pounds of strawberries. Proceed as for strawberry jam.



## STRAWBERRY JUICE.

Strawberry juice is a refreshing beverage, especially when combined with other fruit juices. One of the best combinations is made by the addition of the juice of one lemon to each pint of strawberry juice. This must be sweetened and diluted according to taste. The strawberry juice is prepared by heating the strawberries almost, but not quite, to the boiling point, and at once straining out the juice. Strawberry juice will not keep its flavor or color for long periods unless stored at low temperatures.

## COLD STORAGE.

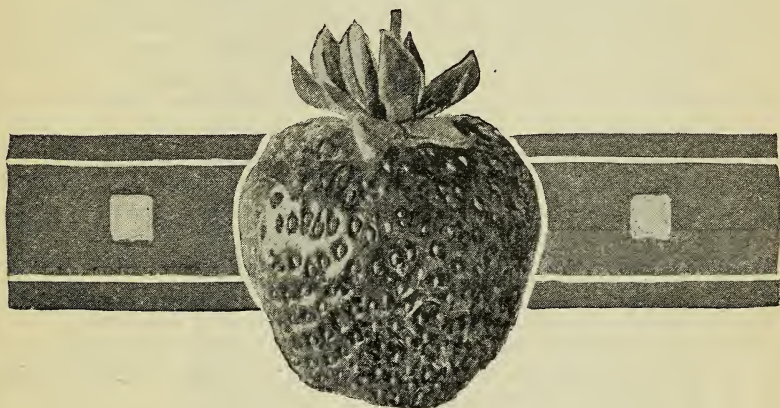
**First method.**—When the preservation of the fresh-fruit flavor is desirable the following method may be used for packing small quantities of strawberries for use when they are not in season. Select sound, ripe berries; wash and hull. Use a tin of convenient size to which a tight cover can be fitted. To each 10 pounds of fruit use one cup of sugar; fill the cans with sugar and berries; put on the tops and cover their edges with adhesive tape such as is used in sealing packages; put in freezing cold storage and keep frozen until wanted. This product can be used for shortcakes, etc., by restaurants and hotels and for crushed fruit at soda fountains and by ice-cream manufacturers.

**Second method.**—The large manufacturers of the crushed fruits and sirups used by the soda-fountain and ice-cream trades prepare their product as it is needed at any time during the year from uncooked berries which are kept in barrels in cold storage preserved in the following manner: The berries are hulled and sorted and then washed. The washing is done by running the berries on a belt through a tank of water, then over another belt, where they are slowly turned and sprayed with water. The berries then drop into pans and are weighed. To each pound of berries, sugar is added varying from one-half to 1 pound. Usually, however, the proportion is half a pound of sugar to 1 pound of fruit. The proper proportion to use will depend upon the variety, the ripeness of the fruit, the moisture conditions, and the way in which the product is to be used. Heavy, water-tight barrels holding about 375 pounds of the mixture of berries and sugar are used. Before use they are carefully examined and coated on the inside with paraffin, which is applied while hot with a paintbrush. New barrels may need special treatment to prevent the berries from absorbing a woody taste. The sugar and berries are put in alternate layers and mixed by machine or by hand. As soon as the barrels are headed they are shipped in refrigerator cars to a cold-storage warehouse, where they are held at a tempera-

ture of 30° F. or lower. Several thousand barrels of strawberries are put up in this manner every year.

After washing, the berries are sometimes dropped into a mixing tank, where the sugar and berries are thoroughly mixed by constant stirring. This tank is surrounded with ice water, in order to cool the fruit before it goes into the barrels.

If equal weights of sugar and berries are used, the barrels of fruit may be stored at a temperature of 34° to 36° F., but if the fruit is to be held for long periods the flavor is best preserved at a lower temperature.





# **ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.**

November 1, 1923.

---

<i>Secretary of Agriculture</i> -----	HENRY C. WALLACE.
<i>Assistant Secretary</i> -----	HOWARD M. GORE.
<i>Director of Scientific Work</i> -----	E. D. BALL.
<i>Director of Regulatory Work</i> -----	WALTER G. CAMPBELL.
<i>Director of Extension Work</i> -----	C. W. WARBURTON.
<i>Weather Bureau</i> -----	CHARLES F. MARVIN, <i>Chief</i> .
<i>Bureau of Agricultural Economics</i> -----	HENRY C. TAYLOR, <i>Chief</i> .
<i>Bureau of Animal Industry</i> -----	JOHN R. MOHLER, <i>Chief</i> .
<i>Bureau of Plant Industry</i> -----	WILLIAM A. TAYLOR, <i>Chief</i> .
<i>Forest Service</i> -----	W. B. GREELEY, <i>Chief</i> .
<i>Bureau of Chemistry</i> -----	C. A. BROWNE, <i>Chief</i> .
<i>Bureau of Soils</i> -----	MILTON WHITNEY, <i>Chief</i> .
<i>Bureau of Entomology</i> -----	L. O. HOWARD, <i>Chief</i> .
<i>Bureau of Biological Survey</i> -----	E. W. NELSON, <i>Chief</i> .
<i>Bureau of Public Roads</i> -----	THOMAS H. MACDONALD, <i>Chief</i> .
<i>Bureau of Home Economics</i> -----	LOUISE STANLEY, <i>Chief</i> .
<i>Fixed Nitrogen Research Laboratory</i> -----	F. G. COTTRELL, <i>Director</i> .
<i>Division of Accounts and Disbursements</i> ---	A. ZAPPONE, <i>Chief</i> .
<i>Library</i> -----	CLARIBEL R. BARNETT, <i>Librarian</i> .
<i>Federal Horticultural Board</i> -----	C. L. MARLATT, <i>Chairman</i> .
<i>Insecticide and Fungicide Board</i> -----	J. K. HAYWOOD, <i>Chairman</i> .
<i>Packers and Stockyards Administration</i> ---	} CHESTER MORRILL, <i>Assistant to the</i> <i>Secretary</i> .
<i>Grain Future Trading Act Administration</i> ---	
<i>Office of the Solicitor</i> -----	R. W. WILLIAMS, <i>Solicitor</i> .

---

This bulletin is a contribution from

<i>Bureau of Plant Industry</i> -----	WILLIAM A. TAYLOR, <i>Chief</i> .
<i>Horticultural Investigations</i> -----	L. C. CORBETT, <i>Horticulturist in Charge</i> .

52

---

ADDITIONAL COPIES  
OF THIS PUBLICATION MAY BE PROCURED FROM  
THE SUPERINTENDENT OF DOCUMENTS  
GOVERNMENT PRINTING OFFICE  
WASHINGTON, D. C.  
AT  
5 CENTS PER COPY  
PURCHASER AGREES NOT TO RESELL OR DISTRIBUTE THIS  
COPY FOR PROFIT.—PUB. RES. 57, APPROVED MAY 11, 1922